Europa Lander Concepts

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Abstract

A Europa Lander mission has been assigned high priority for the post-2005 time frame in NASA's Space Science Enterprise Strategic Plan. JPL worked with the cognizant NASA science team to develop concepts capable of satisfying the principal goals of such a mission and to identify long lead-time technology elements.

Europa is one of the most scientifically interesting objects in the solar system because of the strong possibility that a liquid water ocean warmed by tidal heating exists underneath its ice-covered surface. If a subsurface ocean exists on Europa, it can be assumed to contain both organic molecules and heat sources from tidal effects, the decay of radioactive elements, and geophysical mechanisms. Europa's subsurface ocean environment may be similar to that of the deep ocean hydrothermal vents on Earth where life has recently been detected. If life exists (or existed) on Europa, it may pervade the liquid portions of the planet and perhaps be detectable in the dark fracture-filling material from recent ocean outflows on the planetary surface. The primary scientific goals of the proposed Europa Lander mission are to characterize the surface material from a recent outflow and look for evidence of pre-biotic and possibly biotic chemistry. Secondary scientific goals are to study the seismicity of the Europan interior and to conduct other geophysical experiments to gain information on Europa's internal structure.

The baseline mission concept described in the paper involves landing a single spacecraft on the surface of Europa with the capability to acquire samples of material from 1 meter below the surface, perform detailed chemical analysis of the samples, and transmit the results directly to Earth. A Delta class launch vehicle is used for the direct transfer to Jupiter, arriving after a flight time of roughly 2.5 yr. A Ganymede flyby as the spacecraft approaches Jupiter reduces the energy needed for the Jupiter orbit insertion (JOI) and perijove raise (PJR) maneuvers, which place the s/c in a 200-day orbit. There follows a sequence of satellite flybys augmented by propulsive maneuvers to reduce the energy of the orbit until a 6:5 resonance with the target satellite is achieved. Europa orbit insertion (EOI) burn follows, with the spacecraft ending up in a 100-km orbit around the satellite, ready for the descent burn to the surface. Because of the large delta V required (4 km/sec), the propulsion system comprises about 90% of the 1300 kg launch mass.

The paper provides a detailed discussion of the benefits and development status of the key spacecraft and instrument technologies needed to accomplish the Europa Lander science objectives. The spacecraft will require novel, lightweight, radiation-tolerant components, particularly for the propulsion system. It will also require new devices for acquiring, distributing, and processing surface material and it must be able to perform a precision landing on Europa's surface. However, perhaps the most critical new technologies are those necessary for the instruments which will perform the desired scientific investigations. Particularly important are isotopic/gas evolution/mass analysis instruments and instruments for elemental composition/mineralogy analysis.

Also described in the paper are some variations on the baseline concept including the addition of small auxiliary probes delivered to different surface locations and the addition of

an experimental ice penetration probe designed to reach and transmit science data from depths of 10s to 100s of meters.